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ABSTRACT

Examined in this booklet, one of a series intended to apply economic principles to major social and political issues of the day, are such questions as the origins of interest in combating pollution, why people pollute, continuing interest in the issue, the social costs of pollution, and a possible solution to the problem, all considered from an economic point of view. It is argued that the common thread among all forms of pollution is the existence of spillover costs passed from the polluter to the surrounding area, rather than absorbed as part of the production costs. Thus, factories pollute because the costs of pollution generally fall into areas which are not privately owned, such as the air or rivers. It is emphasized that assessing costs of pollution is often difficult, because the people affected are often already being compensated, by higher wages for more dangerous work or by paying less for housing near the noise of an airport. Graphs are used to demonstrate the marginal costs to society of additional units of pollution, the marginal benefits derived from lower costs for waste disposal, and the intersection of the two. With regard to present pollution control efforts, which focus on rules and subsidies to combat pollution, such efforts are expensive and might better be replaced by alternative methods. For example, a pollution tax matched to spillover costs or a market for pollution rights would permit a certain amount of pollution to be discharged and companies could vie in the marketplace to purchase these rights. (IS)

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Introduction

During the 1960s, the United States became actively involved in a search for a solution to the "pollution problem." People suddenly became terribly concerned about pollution of the environment. We heard over and over again that "our air is unfit to breathe, our water is unfit to drink, our forests are unfit to walk in." If the 1950s were (as a popular television program asserts) the "happy days" and the 1970s were the "decade of the [energy] crisis," we feel that the '60s should be called the "era of the activist." While much more has been written about the anti-war and civil rights protests of this decade, we must keep in mind that the "flower children" were also in favor of protecting the consumer—and saving the environment.

Indeed, one outcome of the marches and demonstrations of the '60s was the Clean Air Act of 1970. According to environmentalists, this piece of legislation represented the first time Congress established a serious air pollution control program. Another result was the water quality act, passed in 1965 with expanded standards established in 1970.

Notwithstanding all the anti-pollution laws and regulations passed since the 1960s, we still see and hear in the media and on the floor of Congress that the Environmental Protection Agency is not doing a good enough job. Former Secretary of the Interior, James Watt, was accused of being this century's greatest benefactor to those who want to pollute our environment. In short, there is still a great deal of interest in doing something about the "browning of America." The topic is hot, and will remain hot, particularly in the light of the recent problems in the EPA.

Let's take a close look at the pollution problem. We want to show why people in the 1960s became interested in the environment. Even more we want to analyze why people pollute. The answer obviously is not that they want to see foul land, breathe contaminated air and drink impure water. We will look at some of the social costs of pollution, but we will also show some of the costs involved in reducing pollution. And, most important, we want to suggest some possible "solutions" to the problem.

I. The Pollution Problem

Why did Americans become so interested in the environment during the 1960s? Did pollution first become a problem during this decade? Certainly not. In 1880, Rudyard Kipling described the air in Chicago as "dirt;" according to Julian LeGrand and Ray Robinson, another visitor described the river as "coated with grease." In 1881, one of the newsmagazines of the period asserted that "no dumping ground, no sewer, no vault contains more filth . . . [than] the air in . . . [New York] City." Given these reports it is clear that pollution has been with us in America for at least 100 years. Were we to go back much further—all the way back to the sixteenth century—we would find perhaps the earliest record of L.A.'s smog! The first Spaniards to explore the area that is now Los Angeles reported that the smoke from Indian campfires was trapped over the basin (by what we call today the "inversion layer.")

During the early days of the Industrial Revolution in Britain, when industry was switching from wood to coal as a fuel, the smoke in the air was noxious. Observers at the time noted that breathing the air of London was "hazardous to your health." The streets were covered with filth. The same was true during the industrialization of America. It was not without cause that Pittsburgh was called the "Smoky City." And think about the street pollution in crowded cities where the only form of transportation was by horse. If you want to go back still further, there exists evidence that the drinking waters of Rome had become polluted in the first century B.C.

So, pollution is not new. Why then was it only in the 60s that we in America finally began to "do something" about it? We propose two reasons.

First, by the 1960s, more and more people were subject to the effects of pollution on a daily basis. In 1880 only 28 percent of the population of the United States lived in cities, but by 1960, 63 percent lived in cities. As a larger and larger proportion of the population became exposed to pollution, political pressures increased on the government to "do something—anything."

A second reason for the rise of the environmental movement in the 60s was the very simple fact that we felt that "we could afford it." In the 1950s, we in America had experienced a decade of economic growth and technological improvement that was unprecedented. In the 1940's all resources were devoted to fighting a world war and changing from a war to a peace economy. Of course, in the 1930s the country experienced its longest and most severe depression. A nation with massive unemployment doesn't think about the esthetics of a clean environment.

But during the 1960s, Americans felt they could do anything. So in that decade (and the early seventies), we tried to do everything—all at once. We tried to fight a major war, rebuild our cities, eliminate poverty and clean up our environment all at the same time. (And, as you know,

these programs and the budget deficits that went with them produced the inflation that ravaged this economy in the '70s. But that's another story.)

Since 1960, private industry and the government have spent billions of dollars on cleaning up the environment. Congress has passed a multitude of environmental laws designed to force businesses to clean up the environment. Compliance with these laws costs billions. Has it been money well spent? Put another way, did we get the most clean-up for our money? It is this question that lies at the heart of this essay.

Before we can begin to answer that question, however, we need to understand the "pollution problem." In the remainder of this section, we will look at some of the different types of pollution that exist, and then ask the important question of why government should be involved.

A Common Thread

Let's pause to take a look at some of the different forms of pollution. To keep it simple, let's limit the discussion to four forms of pollution.

1. Air Pollution

Air pollution is the type of pollution with which most of us are the most familiar. In the early '70s we were told that "15,000 tons of filth are dumped into the air of Los Angeles County every day" and that "the toxins in New York City's air make a day's walking and breathing the equivalent of smoking two packages of cigarettes." Scientific evidence that linked air pollution to lung cancer, emphysema, pneumonia and other respiratory diseases began to mount. Scientists argued that if current trends in the use of the automobile continue, large portions of the U.S. will be rendered uninhabitable. (It is interesting to note that once the automobile was lauded as a means of reducing urban pollution—the pollution that was left in the streets by horses.)

More recently, attention has been centered on the problem of acid rain, thought to be caused by emissions of sulfur dioxide and nitrogen oxides by power plants, industries and automobiles. Acid rain has been characterized by the Conservation Foundation as "invisible, menacing, pervasive, and of potentially great destructive power." In 1980, *Time* reported that acid rain may cause as much as $2 billion each year in damage to structures in the U.S. In 1981, *The New York Times* reported that acid rain has wiped out fish life in hundreds of lakes in the Adirondacks, Canada and Scandinavia.

2. Water Pollution

In the '60s and early '70s, most of the attention was given to rivers, streams and lakes. We were told that Lake Erie was "dying," having "aged" 15,000 years since 1900. The Cuyahoga river that feeds into Lake Erie had become so permeated with sludge and oil that it twice caught fire.

More recently, concern has centered on the contamination of ground water—the water supplies contained in underground aquifers—with organic industrial chemicals. In 1981, *The New York Times* reported that the aquifers which supply half of the nation's water are contaminated. Indeed, one expert asserted that "tap water is slowly becoming what you bathe in or use to wash your clothes, while drinking water is becoming something you buy in a bottle at the supermarket."

3. Ground Pollution

Closely allied to the problem of contaminated aquifers is the more general problem of toxic waste seeping into the environment from dumps or underground burial sites. The most well known instance is the Love Canal area of Niagara Falls, New York. However, experts assert that there are at least 50,000 toxic waste dumps across the United States. The EPA points to at least 14,000 of these dumps as potentially dangerous. Environmentalists say that figure is low. One estimate of the potential cost of cleaning up all the chemical dumps in America is $260 billion. In March 1983, the EPA spent $36 million to buy Times Beach, Missouri, a town made inhabitable by such waste. There are presently 418 toxic waste sites scheduled for top-priority clean up. This type of ground pollution is becoming increasingly prevalent.

4. Noise Pollution

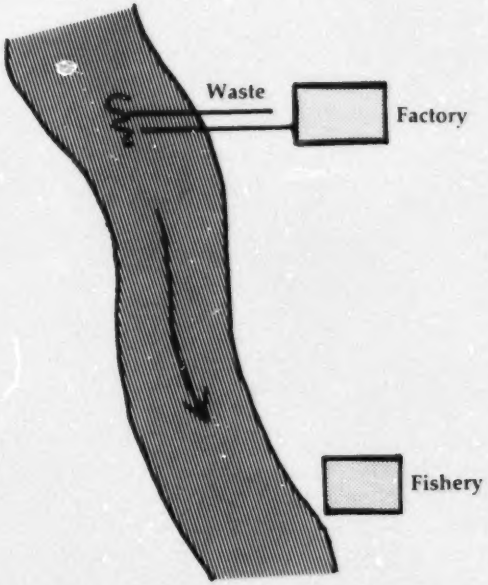
Experts argue that at least 15 million Americans are exposed to *harmful* noise levels and nearly half of the population is exposed to enough noise to interfere with speech, sleep, relaxation and privacy. While much noise pollution occurs in the workplace, an area receiving much attention recently is the level of noise associated with living near an airport or a busy highway.

What is the common thread in all of these types of pollution? In every instance there is a *spillover cost* from the polluter onto the surrounding area. These spillover costs are called *externalities*. To see this more clearly, let us resort to a stylized example. In the following figure we have illustrated a river with a factory located upstream and a fishery located downstream. To produce its output, the factory will by necessity produce some waste. The question is what will the factory do with the waste? It could hire another firm to haul it away—or it could dump it in the river. If the firm dumps it in the river, we have a spillover cost. The factory has pushed some of its costs of operation—the cost of waste removal—onto the fishery. How so? If the river becomes polluted, many fish will be killed and the fishery's is harvest will be smaller. Costs were "spilled over" from the factory to the fishery.

In other words, the factory does not have to pay all of its costs of production. Certainly it must pay for the labor, machinery, raw material and so on used to produce its product. But it does not have to pay for the damage its waste causes to the downstream fishermen. This damage is paid by the fishermen themselves in the form of lost earnings because of

the diminished fish population—and of course by consumers who will be forced to pay a higher price for fish. This is where the externality takes place. From a social point of view, the factory is producing too much output. The fishermen and consumers of fish would be better off if the factory produced less output and hence less waste material.

Of course, the problem is that if a factory produces less product—say shoes—its customers will be made worse off in the sense of having fewer shoes available. If the factory pollutes and produces more shoes, the fish eaters will be subsidizing shoe buyers. If the factory reduces its output and hence its pollution, fish eaters will benefit at the expense of shoe buyers.



The same thing is true for the other examples of pollution we have mentioned. The mill that burns coal and belches smoke, which damages the houses and other property around it, causes an externality. Those whose property or health is damaged by the smoke pay part of the mill's cost of production. They would be better off if the mill produced less. People who live along a railroad track or busy highway are bothered by noise from the passing trains or motorists. Neither the railroads nor the

drivers have to compensate the residents for the noise pollution they are causing.

We could go on and on, but we know that you can think of many other examples yourself. Pollution, as we define it, is simply a case of spillover costs or externalities.

A Market Failure

If we know that pollution is an example of a spillover cost, where does that take us? What we really want to know is why governmental action is required, and what type of action it should be. Why can't the market eliminate the problem?

The first thing we should note is that a good produced with a spillover cost is always overproduced from a social point of view. Because the firm can transfer some of its costs to someone else—i.e., spill over some of its costs—the firm will be induced to produce more than it would if it had to pay all of its costs, including waste disposal. Return for a moment to our simple example. Since the factory is able to spill over some of its costs, what will happen to the level of output it will produce? It will rise. And as output rises, pollution increases.

Since this pollution imposes costs on the fishery, why doesn't the fishery do something to control the pollution? Again there is a simple answer: The fishery does not own the river. Because it has no property rights to the river, it cannot limit the amount of waste discharged into the river. And therein lies the root of the "pollution problem"—no one owns the river. Put more generally, the "pollution problem" results from the fact that the property rights to some things—like air and water—are not assigned.

To help you understand this important point let us answer another question: Why did the buffalo disappear from the American west? When we were in school, a history professor asserted that the reason was the introduction of the Winchester rifle. Unfortunately, he was wrong. The repeating rifle simply meant the buffalo would be eliminated more quickly. The reason the buffalo disappeared was because no one owned them. Think about that for a moment. Since you do not own the buffalo, would you *not* shoot one today just so it could be there tomorrow? Certainly not. The next guy through will shoot it if you don't. So, it would be in your best interest to shoot it now before someone else does. With everyone behaving in the same way, the final outcome is guaranteed—the buffalo is exterminated.

Yet at the same time there was no problem with people shooting cattle because people owned the cattle. Consequently they took strong measures to protect them from elimination or theft. Cattle rustlers were frequently hung on the spot, quite often without the nicety of a trial. People with property rights to the cattle had every incentive to protect their valuable resources.

So buffalo were overkilled because no one had property rights to them. We already have argued that a river or the air would be overpol-

luted because no one owns those resources. Even more generally, we can say that if no one owns a resource, the resource will be overutilized. To understand this point, try answering the following questions:

1. Why is there a "bag limit" on deer and none on cattle?
2. Why are whales an endangered species?
3. Why do people throw beer cans on the side of the road and not in their own front yards?

In every case, the answer is no one owns the property rights to the particular resource—be it deer, whales or the roadside.

Hence, we can finally say something about the "pollution problem" in general. We know that it is an example of an externality—a spillover cost. More importantly, we can see that the market is unable to solve the problem because property rights are incompletely assigned. If no one owns the air, everyone will have the incentive to overutilize it—over pollute it. The same thing is true about all of the forms of pollution.

Returning to our factory/fishery example, if the factory owned the river, the fishermen could pay the factory owners to reduce some of its polluting activity and not kill so many fish. On the other hand, if the fishermen owned the river, the factory would have to pay them for the right to pollute. In this way the fishermen would be compensated to some extent for reduction in the fish population. In either case there would be a movement toward a more optimal rate of pollution. Note that in both cases, pollution would be reduced, but it probably would not be totally eliminated by either type of property rights assignment. Nonetheless, either type of property rights assignment would foster a movement toward a more optimal rate of pollution. We shall return to this type of arrangement below.

II. The Cost of Pollution

In the preceding section we discussed the pollution problem in general and how it represents a problem of spillover costs. In our example, the costs of pollution could be measured very simply as a reduction in the number of fish caught from a river. In a large, complex economy, however, calculating the costs of pollution become more difficult.

Only a small fraction of the costs of pollution can be estimated in a straight forward manner. These are the direct monetary costs of pollution. For example, if air pollution reduces the usable lifetime of automobile tires by 10 percent, a direct monetary cost of pollution would be 10 percent of total tire expenditures. Using such a line of reasoning, it was estimated that in the mid-'70s pollution in New York City imposed extra costs of $200 per person per year. These were the direct costs of painting, laundry, etc.

Other cost estimates also are huge. For example, $100 million a year is spent to paint steel construction, purely because of air pollution. One study estimated the costs of cleaning buildings in two cities with

significantly different levels of pollution. The cost per year was $84 more for a person in the more polluted city. It costs $800 million a year to clean and wash textiles damaged by pollution. The damage to trees and plants from air pollution is $4.9 billion a year.

Pollution also can reduce the market value of assets. For example, how much would you pay for a house beside the Love Canal, a heavily polluted area in New York? The ground pollution in this area was a direct monetary cost that could be measured by the reduction in property value. A study of property values in St. Louis estimated that a significant reduction in the level of sulfur in the air would increase the value of houses in St. Louis by $85 million. A similar argument has been made about noise pollution. For example, the Council on Wage and Price Stability estimated in 1977 that property values around airports have declined by $3.25 billion because of noise pollution.

Other direct costs that are somewhat more difficult to measure are health care costs resulting from pollution. The U.S. Council on the Environment estimated that in 1977 pollution control devices saved $30 billion on total pollution-related health care bills for the United States. Even with the controls and the reduction in pollution that resulted, the Council estimated that the health care costs of air pollution amounted to $10 billion per year. A 50 percent reduction in air pollution in major urban areas would, according to one estimate, reduce mortality from lung cancer by 25 percent and morbidity and mortality from bronchitis between 15 and 50 percent. Cardiovascular mortality would be reduced by 20 percent.

In addition to the monetary costs that we have mentioned, pollution also imposes costs that are often referred to as "intangible" or "noneconomic" costs. Included in this category are such things as burning eyes and dead fish. When you look at a dirty river, pollution has imposed some psychological costs on you, but how much? That, unfortunately, is the problem—it is extremely difficult to quantify these costs.

The upshot is that we are unable to put a price tag on pollution. Since many of the costs are difficult to measure or are "intangible," it is frequently impossible to determine how much pollution is costing us. However, we Americans seem to be saying that the costs are very significant. To see this point, note first that we are currently spending about 2.5 percent of our annual Gross National Product on pollution controls. Taking the GNP at $1.5 trillion, gives an expenditure of some $38 billion annually. If pollution costs less than this, the citizens of the United States should want to "slow down the rate at which we are working to improve the environment." The results of a 1981 *Newsweek* poll indicate that people do not want to reduce expenditures on pollution control. According to *Newsweek*, "a solid majority [55 percent] of Americans are willing to pay the added price of environmental safeguards." This survey indicates that Americans view pollution as imposing a high cost on them. And in a period of high energy costs and

growing unemployment, Americans still express a desire to reduce pollution, which means its costs must be perceived as substantial.

An Aside—The Problem With Private Compensation

If, as we noted earlier, pollution imposes costs on individuals, why not simply permit the individual to sue the polluter for damages? For example, if pollution lowered the value of my house by $1,000, shouldn't I just sue the firm that emitted the pollution for $1,000? Indeed, there are currently many lawsuits of this type in the courts. There is, for example, a $124 million suit filed against Hooker Chemical (in the Love Canal case) and lawsuits totaling more than a billion dollars have been filled over noise pollution.

In addition to the more general issue that property rights to clean air or quiet have not been assigned, we see another problem with this kind of a suit. To illustrate our concern, let us give you a concrete example.

Let us consider a home that is located near an airport—an example that is quite common in the pending lawsuits. Clearly, the noise from aircraft takeoffs and landings make this property less desirable, so the market value of this house will be less than it would be in a different neighborhood. Should the homeowner be allowed to sue the airport for this differential?

Our answer is, "It depends." More specifically, we think that it depends upon whom was there first. Let's look at two cases:

CASE 1—If the home was there first (i.e., if the owner bought the home before the airport was built), then the airport clearly imposed a cost on the homeowner for which he has not been compensated. In this case, we feel that the lawsuit would have *economic* merit. The person bought or built the house without the knowledge that the airport would be built. Thus the airport has imposed a real cost on the homeowner.

CASE 2— Suppose the airport was there first and that the surrounding houses were erected later. (To the best of our knowledge, this is the more common case with respect to airports.) Let's think about the price that the homeowner paid for the property. Because it was located near an airport wouldn't the price be low? In other words, hasn't the homeowner already been compensated for the noise—or the probability of noise in the future—with a low purchase price for the house?

Certainly, people would be willing to pay less for a house near an airport than they would for an identical house in a quiet neighborhood. Thus we would think that there would be a lower demand for houses near airports than for houses elsewhere, other things remaining the same. This reduced demand would lower the prices of homes subject to noise pollution.

But many people are willing to suffer the noise in return for lower house payments. Others are willing to pay more for their homes if they do not have to suffer the noise. Thus the market results in people most willing to bear the noise living near airports. So of course these home-

owners who buy homes near airports have been compensated for the noise in the form of lower priced homes.

If we then allow the homeowner to sue the airport for "noise damages," the homeowner will have been compensated *twice*. Hence, in this case we see no *economic* justification for the suit. (Note however that this economic rationale is not recognized in U.S. courts.)

Hence, when considering claims for damages from pollution, we think that it is essential to decide whether or not the individual has already been compensated. We find this to be a severe problem in noise pollution suits involving airports. A very similar type of problem is found when people build homes near major highway arteries.

However, the same type of reasoning should be applied in all types of damage cases. For example, suppose a worker sues for damages to his health from job-related pollution. We think that one should determine whether the risk was known before the fact and whether the worker had been compensated for the risk with a higher wage rate.

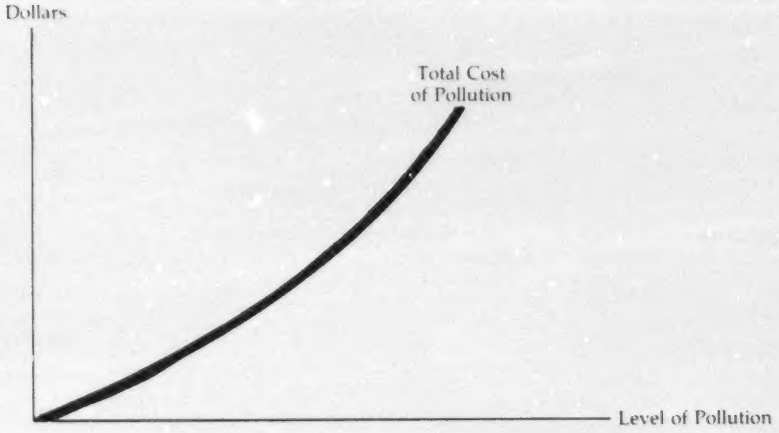
We would expect that firms that subject their workers to less desirable working conditions—noise, bad air, danger—would, other things the same, be forced to pay wages higher than those paid by firms with more desirable working conditions. The supply of labor would be clearly lower in the former case than in the latter. Thus, as was the case for homes in less desirable areas, workers who are most willing to trade off less desirable working conditions for more income would work in those types of jobs. Conversely, those who most value improved working conditions will work in those jobs, for lower wages.

In such cases, if the polluting firm is required to pay compensation or to reduce or even eliminate pollution, those who chose to be subject to the pollution, because of reduced prices in the case of property or increased wages in the case of jobs, are compensated twice. This then is the problem with estimating the costs of pollution. Many times the costs have already been paid. The market already would have solved the problem.

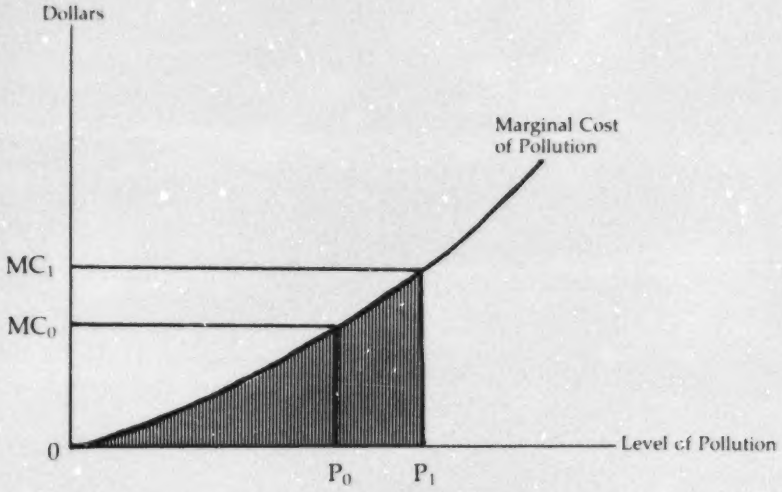
III. Zero Pollution?

To extend our discussion, we might ask, What is the optimal level of pollution for a society? Were you to ask this question to persons on the street, many if not most persons will respond with "none." However, is no pollution really the best solution for a society? Let's examine this situation using what we have discovered in the preceding sections.

Let's begin with costs—the topic discussed in the preceding section. Apparently, the more pollution we have, the greater are the costs; so, if we graph the dollar costs of pollution against the level of pollution, we would have a rising curve as illustrated below.



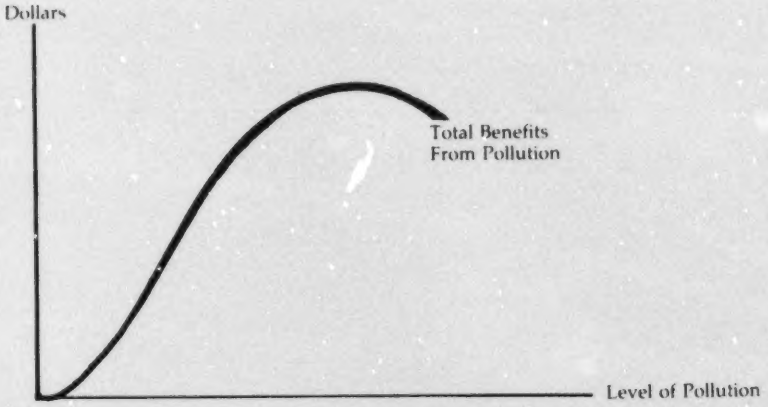
A more relevant question, however, is the marginal cost to society of *an additional unit of pollution?* Mathematically, this marginal cost is simply the change in total cost divided by the change in the level of pollution. In terms of the preceding graph, this marginal cost is the slope of the total cost curve. We have illustrated this marginal cost curve below. (Note that we have assumed that marginal cost is rising, but the analysis would not be altered if marginal cost is constant or falling.)



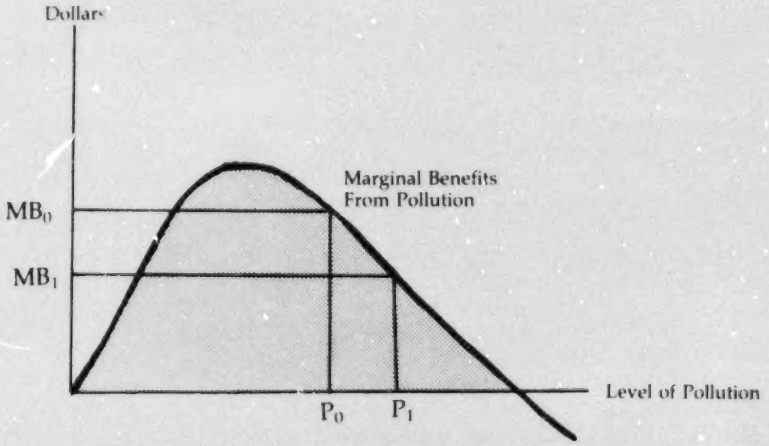
What does this figure tell us? It gives us the damage to society for each additional unit of pollution. Let's look at two points on this curve. At pollution level P_0, marginal cost is MC_0. The cost to society of this last unit of pollution—the P_0 unit—is MC_0 (in dollars). Put another way, society would be willing to pay as much as MC_0 to reduce pollution by one unit from P (i.e., from P_0 to P_0-1), because this is what that unit costs. Conversely, suppose that the level of pollution was currently at P_0-1 (one unit below P_0). How much would society be willing to accept to permit someone to add an additional unit of pollution? The answer is MC_0. At a higher level of pollution, P_1, the marginal cost is higher, MC_1. Hence, society would be willing to pay more to reduce pollution by one unit from this level, or, conversely, would demand a higher payment to permit an additional unit of pollution to be added. As a numerical example, suppose we have a factory near a residential area. The smoke from the factory costs the homeowners say $100,000 a year in extra painting cost and building damage. If the factory increases its smoke output by one unit (measured perhaps in pounds of soot emitted), these costs would increase by $5,000. This figure is therefore the marginal cost of the additional unit of pollution. The homeowners should, therefore, be willing to pay the factory not to emit this additional smoke an amount up to $5,000.

On the other side of coin, the persons or firms that are doing the polluting are deriving some benefits from their polluting activities. Firms don't pollute the air and water because they derive some great pleasure from damaging peoples' property or health. They pollute because that is the cheapest way to get rid of the waste associated with

production. If they did not pollute, they would have to dispose of the waste in some other more expensive way. Thus the benefits from pollution are the disposal costs saved. Below we illustrate a simple total benefits curve for the polluters.



As was the case for costs, we will find it useful to deal with the marginal benefits of pollution. The marginal benefits curve, shown below, can easily be derived from the total benefits curve. Two features of this curve should be noted. First, while the curve may exhibit a rising



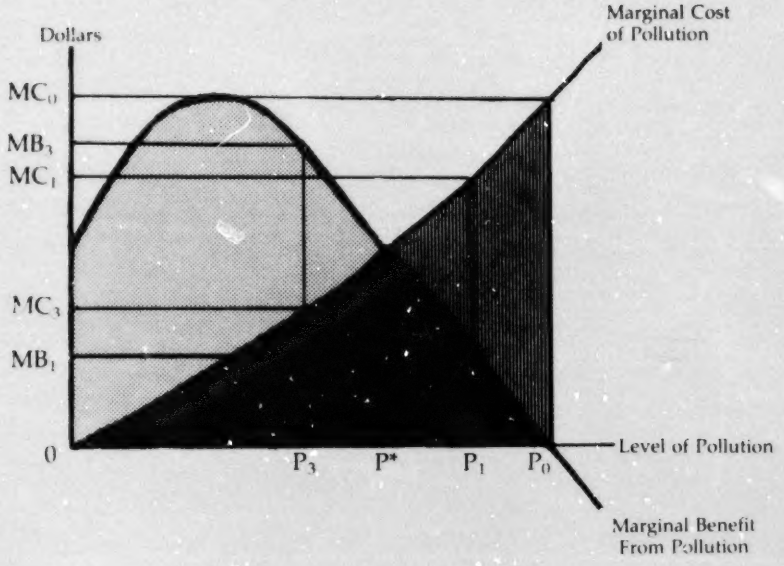
portion (as does the one we have illustrated), the general shape of this curve will be downward sloping. This means that as the firm or individual puts more and more pollution into the environment, the benefit from each additional unit gets smaller and smaller. One way of looking at this is to argue that the pollution also is distasteful to the firm or its workers. Second, there is a point at which marginal benefits will go to zero and then become negative. That is, there is a point at which pollution will reduce the firm's own output. The firm would not want to pollute beyond that point.

Similar to the marginal cost curve, the points on the marginal benefits curve show the value to the polluter of additional units of pollution. For example, consider the level of pollution denoted P in the preceding figure. For this additional unit of pollution the polluter obtains a benefit (cost saving) equal to MB_0 (dollars). This means that if the level of pollution had been one unit lower than this (i.e., at P_0-1), the polluter would be willing to pay as much as MB_0 to increase the level of pollution by one unit. Conversely, inducing this polluter to reduce pollution by one unit from the level P_0 would require a payment equal to MB_0. At higher levels of pollution, the marginal benefit from an additional unit of pollution is lower. Look at pollution level P_1. At this level, the marginal benefit is MB_1. Comparing pollution level P_0 to level P_1, you can see that the polluter would be willing to pay less in order to add an additional unit to the environment.

We can look at the marginal benefits from pollution in the same way we looked at marginal costs. Take for example the smoke-belching factory we discussed above. Suppose the factory is forced to reduce its pollution by one unit. There are two possible choices. The manager can reduce output and thereby reduce its smoke and pollution. If the firm chooses this approach, the marginal benefit from the extra unit of pollution is the additional profits from the sale of the output.

The factory also could produce the same level of output and dispose of the unit of waste in some other way. In this case, the marginal benefit of the unit of pollution is the cost saved from not having to pay for the pollution to be hauled away. So each additional unit has a marginal benefit in the form of cost saving or increased output.

Now, in order to observe some optimal level of pollution, we need to put the marginal cost and marginal benefit curves together. We do this in the following figure.



Remember that the problem inherent in pollution is that no one owns the property rights to air or water. In this situation, how much pollution will exist? Since the use of the environment is "free" to the polluter, the polluter will continue to pollute the environment until there are no more benefits to be obtained. That is, pollution will expand until the marginal benefit of additional pollution is equal to zero. In the figure above, that means that pollution will be at level P_0.

Is P_0 an optimal level of pollution? Clearly not. Think about it this way: The last unit of pollution (the P_0 unit) is worth zero to the polluter in terms of reduced cost or increased output. But this unit of pollution imposes costs on society in an amount equal to MC_0. Society is willing to pay more to reduce the pollution by one unit than the pollution is worth to the firm or individual doing the polluting. So, the optimal level of pollution must be less than P_0. Let's look at pollution level P_1. As you can see, the situation here is similar to that for P_0—the marginal cost (MC_1) exceeds marginal benefit (MB_1); so the level of pollution should be reduced still further.

Let's move to the other extreme and consider the zero pollution point. Is no pollution optimal? Again the answer is no. The benefit to the firm or individual who desires to add one unit of pollution to the environment is clearly greater than the cost imposed on society by that first unit of pollution. Hence the optimal level of pollution must be

greater than zero. Moving up to pollution level P_3, you can see that the marginal benefits from an additional unit of pollution (MB_3) are greater than the marginal cost of society of that unit (MC_3). The polluters are willing to pay more than the minimum society is willing to accept in order to increase pollution by one unit; so, the optimal level of pollution must be greater than P_3.

By this time we are sure that you have seen the optimal point—P^*. At pollution level P^*, marginal cost and marginal benefit are equal. There is no level of pollution that will be preferred to P^*. If the amount of pollution was reduced, the polluters would lose more than society would gain. And if the level of pollution was increased from P^*, society would lose more than the polluters would gain.

So, we now can define some optimal level of pollution, and this level is not equal to zero. However, we have also noted that in a world in which property rights are not assigned, the actual level of pollution will be greater than the optimal level (e.g., P_0 in the preceding figure). That is, in the absence of property rights, polluters will increase their polluting activities until they gain no return from one more unit of pollution. Marginal benefits are zero. Since the marginal cost of pollution would clearly be positive, this situation always means that the cost to society of the additional pollution always exceeds the benefits. Thus a reduction would be desirable.

But how can the socially optimal level of pollution be attained? As was first demonstrated by Ronald Coase in 1960, all that is necessary is that property rights be assigned. And it does not matter to whom the property rights are given. To demonstrate this, look again at the preceding figure. Suppose first that the property rights to the environment were given to the firms and individuals doing the polluting. At the outset, pollution would be at level P_0. However, since the marginal cost of pollution exceeds the marginal benefits, the individuals affected by the pollution will be willing to pay the polluter more to reduce the level of pollution than the extra pollution is worth to the polluter.

In this way, pollution is reduced from P_0 to P^*. At any pollution level above P^* the marginal value of a reduction in pollution is always greater than the lost benefit from reducing the pollution. Pollution would not be reduced below P^*. Any reduction below this level is worth less to society than the benefits that would be sacrificed by the polluters. Thus there would be no incentive for society to pay the price needed for any further reduction. In this way the optimal level of pollution is attained.

Now, let us suppose that the property rights to the environment were given to the persons damaged by pollution. In this case, pollution would initially be at zero. However, since an additional unit of pollution would be worth more to the polluters than it would cost the persons damaged by pollution, society would be willing to "rent out" some air or water. As long as the marginal benefit curve is above the marginal cost curve this would be true. The amount the polluter is willing to pay to

rent some pollution rights exceeds the amount society demands to accept the additional unit of pollution. Hence the level of pollution would rise to P* as polluters paid the owners of the environment to allow them to pollute. There would be no incentive for firms to pay society to allow them to pollute more than P*, even though the marginal benefits from pollution are positive at greater levels. The marginal benefits beyond P* are less than the marginal costs. Thus society would demand more from the firms than the firms would be willing to pay.

We might note in passing that in our analysis we have assumed that there are no transactions costs for polluters paying society for permission to pollute or for society paying polluters not to pollute. If these transaction costs are high, there might be a deviation from the optimal level.

To summarize, there does exist some non-zero level of pollution. If property rights are assigned and if transactions costs are not excessive, the workings of the market place will guarantee that this optimal level is achieved. And somewhat surprisingly, it does not matter to whom the property rights are assigned.

IV. Pollution Control in the United States

From a public policy standpoint, the arguments presented in the preceding chapter imply that, without property rights to the environment, too much pollution exists. That is, if no one owns the air or water, the actual level of pollution will always be above the optimal level.

In the United States, we have used several different methods to reduce pollution levels. In this section we will describe these methods to you. Then, let us describe the impact these programs have had on the economy.

Pollution Controls

To reduce pollution in the United States, Congress has passed laws, including the Clean Air Act (1963) and the Water Pollution Control Act (1948), which attack the pollution problem via three methodologies. Following is a brief description of these control strategies:

1. Limit Pollution By Firms

Using a form of direct control, government agencies in essence tell each firm how much pollution it can emit into the environment. Water and air quality management in the United States is based primarily on such a permit system. The Environmental Protection Agency was established in 1969 and was given the task of setting and enforcing the limitations. Because each individual firm is regulated, the magnitude of the enforcement costs is immense. For example: During the period 1972-1976, 46,000 permits were issued for water pollution alone.

The permits most often require that firms use "state of the art" technology. That means the EPA will tend to concentrate upon what is

technologically feasible rather than what is economically feasible. As should be apparent from the preceding discussion, this approach can cause very expensive measures to be used to reduce pollution, and quite possibly pollution levels lower than those that are socially optimal. When firms are required to use the most expensive technology, they may well be forced to reduce emission below the level at which the marginal benefit equals the marginal cost. The reduced pollution is valued less by society than the lost benefit. Thus this frequently is not an efficient method of control.

2. Limit Pollution By Product

Another form of direct control of pollution limits the pollution emitted into the environment by a particular type of product. You are probably most familiar with the limits placed on the exhaust emissions of automobiles. The stringency and impact of these regulations can be seen in the following table.

Emissions in grams per mile

ALL AUTOS

	Hydrocarbons	Carbon Monoxide	Nitrogen Oxides
1970	10.6	74.4	3.9
1978	6.4	55.6	3.0

NEW AUTOS

	Hydrocarbons	Carbon Monoxide	Nitrogen Oxides
1970	4.1	34	3.5
1978	1.5	15	2.0

Note that the reduction in hydrocarbon in particular has been substantial. Thus this type of reduction has certainly improved the quality of the air that many of us breath. But what about the cost? Achieving the reduction in auto emission costs the automobile manufacturers substantial amounts each year. Therefore, much of this cost is passed on to automobile buyers in the form of higher prices. So the consumers of automobiles are actually paying the cost of cleaner air. Thus, it may well be that pollution has been reduced too much from society's point of view. The marginal benefit of some of the reduction may be less than the marginal cost—the higher price paid for automobiles. Moreover, automobile purchasers who live in Utah or Wyoming, where this type of pollution poses practically no problem, have to pay the same higher prices for little-needed pollution control equipment

as purchasers in Cleveland or Pittsburgh, where pollution is more of a problem. Thus we may easily have a sub-optimal solution.

However, automobiles are not the only product that is regulated nor are air pollutants the only form of pollution that is limited. For example, the EPA currently sets noise pollution limits on air compressors and trucks and expects to set limits for motorcycles, buses, and tractors in the near future.

3. Subsidies

The federal government also has provided subsidies to municipalities for building waste disposal plants and to firms—in the form of tax reduction—for installing pollution control equipment. One conservation group has estimated that the subsidies required to complete the necessary waste disposal plants will be $120 billion.

In general, we can say that in the United States we have attacked the pollution problem most frequently by directly controlling the amounts of pollutants that can be emitted. (In the next section we will look at some alternative control strategies that have been proposed.) Certainly, we have made progress in cleaning up the environment. As Paul and Ronald Wonnacott have noted, there are now boutiques in Cleveland along the Cuyahoga, a river that used to be so loaded with pollutants that it twice caught fire. And even a critic of U.S. environmental policy concedes:

> The Great Lakes are cleaner and clearer, and fish are returning. Salmon have come back to the Penobscot River in Maine: People in Bangor claim to be catching 20-pounders during lunch hour. "From the Appalachians to the Cascades, shy mountain streams that used to make their escape from paper-mill towns rafted with foam and stinking black with sulfite liquor now manage to sparkle a bit in the sunlight. Crab traps once more dangle from hardware-store ceilings of little towns up the Hudson."

So, we have made some progress against what environmentalists have called the "creeping menance," but at what cost?

The Cost of Environmental Controls

What are the costs of the pollution controls we have instituted in the United States? What are Americans paying to clean up the environment?

The most obvious costs are the direct costs we pay in the form of taxes to enforce the standards imposed by the EPA and to provide the subsidies granted to firms and municipalities for the installation of pollution control equipment. It has been estimated that just achieving the original standards set in the early 1970s would have cost $40-$60 billion per year. (The cost of meeting the 1977 automobile emission standards alone was estimated to be $11 billion.) And these numbers do

not take into account the newer programs and policies dealing with such things as ground and noise pollution.

While the direct costs of pollution controls are significant—$60 billion is almost one-third of the estimated 1984 federal deficit—it is the indirect cost of pollution control that is more worrisome to us. The direct pollution controls that we have described impose a cost on the firms on which they are imposed. How do these firms react? As with any other type of cost, the firms respond by reducing output, and in order to reduce output, they will reduce employment and investment. And as we noted above, prices will rise.

How large are these costs? Our research indicates these costs are quite substantial. For example, we estimated the impact more stringent environmental controls would have on investment in the mining sector of the Canadian economy. Our estimates show the environmental controls imposed in the early 1970s would result in a level of investment some 30 percent below that which would exist without these controls. Our estimate is certainly not unique. According to John W. Whitney, the environmental controls imposed on the copper industry meant that construction costs—capital costs—rose by 20 percent in that industry. Even conservationists admit that pollution controls have increased costs for firms and have resulted in reduced investment. The Conservation Foundation reported that, in 1978, American industrial firms spent an average of 2.38 percent of their total capital expenditures on air pollution control, with steel spending the most—11 percent of total capital expenditures. According to the *New York Times*, the total expenditures firms would have had to make to comply with pollution control requirements in 1978 was $45 billion.

To put the figures in perspective, it has been estimated that in the 1970s, firms in the U.S. annually spent approximately 2 percent of the total GNP on air pollution control. This amount was 500 times the annual amount spent on foreign aid.

Of course, there is also an effect upon unemployment if firms reduce the number of workers hired so they can comply with controls. These numbers are extremely difficult to measure, since the effect of increasing the number of workers in order to comply must be balanced against the reduction in labor because of reduced output. One study did, however, estimate the number of workers who lost their jobs in 1976 because of environmental restriction as 76,000.

Finally, pollution controls have raised the consumer prices for final goods and services. It has been projected that some steel prices will rise as much as 7 percent and utility rates may increase as much as 20 percent because of environmental restrictions. An example that may be closer to home is the impact of emission control requirements on the price of an automobile. EPA has determined that the cost of meeting the 1977-79 standards was $322 per car (in 1977 dollars). The additional cost of meeting the 1981 standard was $260 per car (in 1981 dollars). Hence,

in 1981 dollars, the emission control standards have added some $737 to the purchase price of an automobile.

From the preceding discussion, it should be apparent that the existing pollution controls are relatively costly. We pay for reduced pollution directly with taxes and indirectly with reduced investment, reduced employment and higher prices for goods and services. Furthermore, there are other costs from the existing system that are even more difficult to calculate. For example, the Clean Air Act is designed to "protect and enhance" the quality of the nation's air—a worthy objective, except that the legislation has been interpreted to mean that the air should not be allowed to deteriorate significantly anywhere. As a consequence, even the states with the cleanest air have been encountering problems attracting new firms. This has blocked one avenue for reducing the overall pollution problem, namely, shifting firms from overloaded, highly polluted areas into regions with low pollution levels (where at least some of the pollutants could be "washed away" by natural processes). In essence, firms are prohibited from locating in the most efficient locations.

IV. A Proposal for Pollution Control

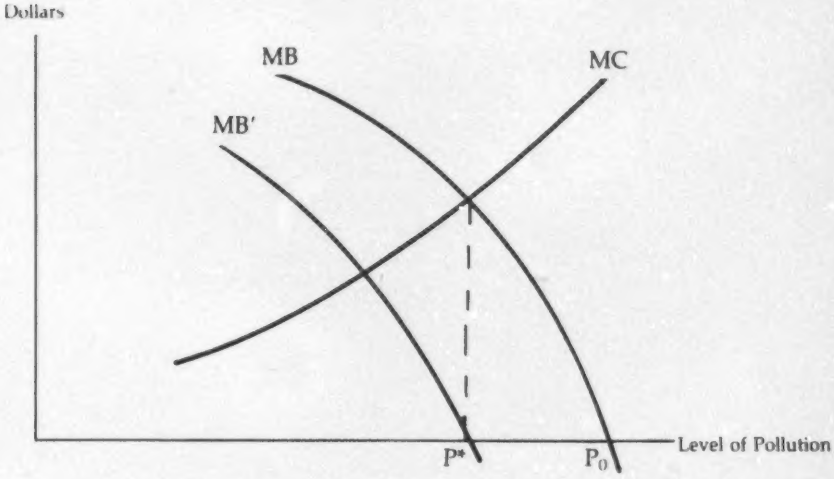
In the preceding section we described the pollution control strategies that the U.S. government has imposed and the impacts of these controls on the economy. In this chapter, we would like to use what we know about pollution in order to suggest an alternative methodology for controlling pollution in the United States.

A Pollution Tax

To set the stage, let us first describe a method of pollution control that has been proposed but not used in the United States—emission or effluent fees. Under this system, a special tax or levy would be assessed for each unit (e.g., ton of pollutant) that the firm or individual discharged into the environment. The idea is to set a fee that exactly matched the spillover costs, so the firm would in the end by paying all costs of production. While such a system has been used effectively to control water pollution in Germany's Ruhr River basin, a bill that proposed such a system of taxes in the United States died in Congressional committee in 1969.

The advantage of the pollution tax is that it "permits the market to function." In essence, it increases the costs of polluting to the firm or individual. Alternatively, it reduces the benefit from pollution. We can illustrate this in the figure we developed in Section 3. Below we have again illustrated the marginal benefit and marginal cost curves. Note that, in absence of property rights assignment, the polluting firm will produce pollution level P_0, while the optimal level of pollution is P^*. The

polluter will continue to discharge pollution until the marginal benefit is equal to zero.



Now, suppose we institute a pollution tax such that the more pollution the firm emits, the higher the tax. Thus the *total* marginal benefit from each additional unit emitted is the original marginal benefit minus the amount of the tax that must be paid. If the marginal benefit of an additional unit is $1,000 and the tax levied upon that unit is $400, the net marginal benefit is reduced to $600. The effect is that the marginal benefit curve rotates downward. By imposing the "correct" tax structure, society can induce the polluting firms to emit the optimal amount of pollution.

Suppose that the tax rate is such that the marginal benefit curve rotates to MB'. With this new marginal benefit curve, the polluters, as before, will continue to produce pollution until net marginal benefits are zero. But the level of pollution that will be produced is now equal to P*. A pollution tax can be used to reduce the level of pollution in the economy. Indeed, it is *possible* that a pollution tax could be set such that the level of pollution forthcoming would be that which was optimal before the tax was imposed.

More importantly, since firms react to the tax signal alone and then try to minimize their own costs, pollution is reduced in a less costly way—society devotes fewer resources to get the same amount of clean-up. In other words, firms not only reduce pollution but also reduce it in a more efficient way than would be the case under controls. Indeed, it

has been estimated that a pollution tax would cost 40-90 percent less than would a direct control program that obtained the same reduction in pollution.

A problem with the pollution tax is setting the tax rates. More specifically, who will set the rates and how will the numerous different tax rates be set? Should the taxes be set at the federal level, the state level, or the city level? Indeed, how should we treat governmental units, since they themselves are major polluters?

As to the tax rates, the problem is that different types of pollution are interrelated. If we impose an emission tax on pollutant A, it can lead to more pollutants of type B. Or, a pollution tax can transfer the pollution from one medium to another (e.g., from the air to the water).

Indeed, it has been asserted—probably correctly—that the stringent water and air pollution regulations of the 1970s are to a large extent responsible for the serious toxic dumps problem we are hearing so much about now. After all, if wastes cannot be emitted into the air or the water, they have to go somewhere. And the "somewhere" happens to be in toxic dumps. Where do they go if there are no dumps? Clearly this is a serious problem.

Hence, in order for a system of pollution taxes to *really work*, the tax system would be immensely complicated. And in such a situation, if some outside condition changed, all of the taxes would have to be readjusted. So what is an alternative solution?

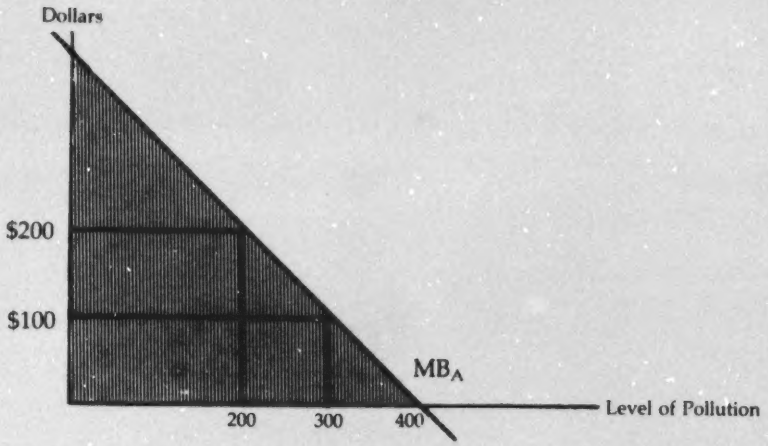
A Market for Pollution Rights

Let's go back to the beginning. The cause of the "pollution problem" is incomplete assignment of property rights. So, if we could assign property rights, wouldn't that eliminate the problem? Indeed, that is the way economists would prefer handling the situation.

The pollution tax we described above is a movement in that direction; but as we noted, it has a lot of drawbacks. Specifically, it is hard to set the price charged for pollution—the pollution tax rate. And who is to assure that those who are damaged by the pollution are the ones who receive the returns from the pollution tax?

Because of the pricing problem inherent in any pollution tax system, economists have recommended that a market for pollution rights be established. To illustrate how such a market will operate, let us provide a very simplified example.

How much is a firm willing to pay for a "pollution right"—the right to discharge one unit of pollution into the environment? Remember the marginal benefits curve we described earlier? In the following figure, we have illustrated the marginial benefit curve for firm A. For the right to emit 200 units into the environment, the firm would be willing to pay $200/unit. For the right to emit 300 units, this firm would pay $100/unit. If the price of pollution rights falls to zero, this firm will emit 400 units.



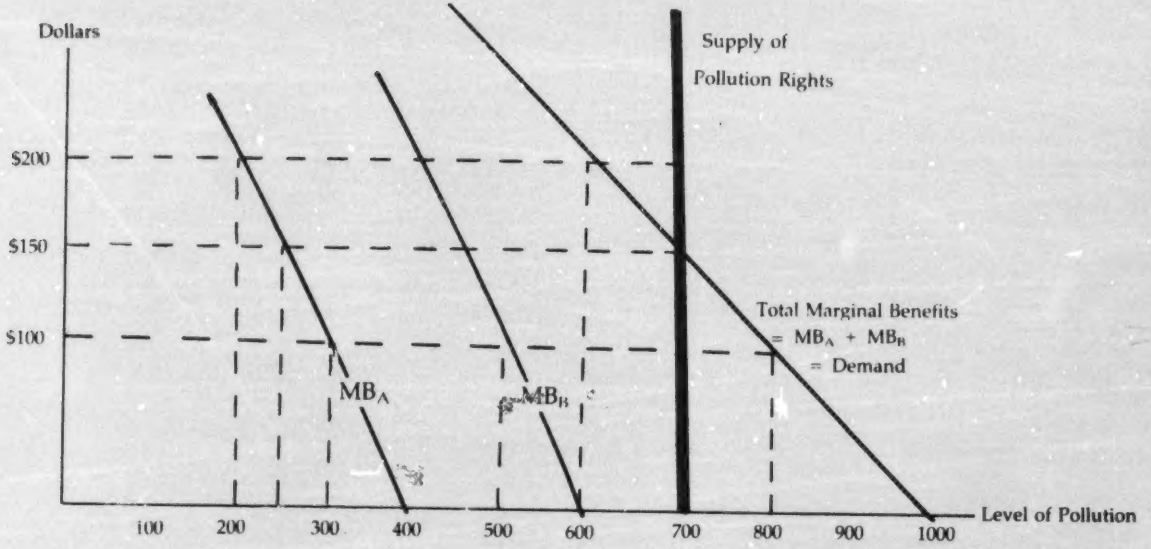
For the right to emit 300 units, this firm would pay $100/unit. If the price of pollution rights falls to zero, this firm will emit 400 units.

Now, let us suppose two firms exist in our region. In the following figure we have illustrated the marginal benefits curves for each of these firms as MB_A and MB_B. Each of these curves represents the firm's demand for the right to pollute.

That is, for each price of pollution rights shown on the verticle axis, the marginal benefits curve shows how much the firm would pollute if it had to pay this price for the right. If the price of pollution rights is $200 per unit, firm A with MB_A would pollute until the marginal benefit from its last unit of pollution is $200; it would emit 200 units of pollution. Following the same line of reasoning, firm B with MB_B would emit 400 units.

Summing up the pollution of the two firms, we can see that at this price the two firms would want to emit 600 units. It is easily seen that at a price of $100, firm A would wish to emit 300 units and firm B, 500 units. The total pollution demanded at this price is therefore 800 units. We can add MB_A and MB_B at each per-unit price of pollution and obtain the Total Marginal Benefits curve, which is, of course, the market demand for pollution shown in the figure. For example, if the price of the right to emit one unit of pollution is $200, firm A will desire to emit 200 units and firm B will desire to emit 400 units; so, the total "demand" for pollution rights at $200 is 600 units. Likewise, at $100 per unit, the total demand will be 800 units, and so on.

Before we go further, let's review what would happen in a world with no property rights. How much pollution would exist? If no one owns the rights to the air or water, each firm will continue to pollute


Dollars
Supply of
Pollution Rights
$200
$150
$100
Total Marginal Benefits
= MB_A + MB_B
= Demand
MB_A
MB_B
100
200
300
400
500
600
700
800
900
1000
Level of Pollution

until the marginal benefits from any additional pollution are equal to zero. Hence, firm A would have pollution level 400 and firm B would emit 600 units; so, total pollution would be 1,000 units.

Suppose the region—e.g., the city—has determined the acceptable level of pollution is equal to 700 units. (For a more concrete example, let's suppose we are talking about sewage and that it has been determined the municipal lake can effectively recycle 700 tons of sewage.) Hence, the pollution control agency for the region will offer 700 "pollution rights" to emit one ton each for sale. As you will note in the preceding figure, this means that firms will bid the price of pollution rights up to $150 each. Firm A will purchase 250 rights and firm B will purchase 450 for a total of 700. If the price did not rise to $150 firms would wish to purchase more than the total amount available. This demand in the market would cause the price to increase.

Now, let's see what will happen if another firm wants to set up business in this region. In order to operate, it would need to have some pollution rights. The pollution control authority is willing to sell no more, so where would the new firm get its pollution rights? It would have to buy them from firms A and B. And, as you can see from the figure, this would mean that the price of pollution rights would have to rise. From this you can probably see that this plan would create an incentive for each firm to reduce its own pollution. If firm A could find a way of reducing pollution, it could sell some of its pollution rights to firm B or to a firm that wants to enter the region.

Furthermore, this system permits the environmentalists to have an effective voice. Suppose that a particular group felt that 700 units of pollution was too much. If they wanted to reduce pollution below this level, they can simply buy some pollution rights. By buying pollution rights and holding them off of the market, conservationists can directly reduce the level of pollution. Clearly, this would cause the price to rise even higher.

The major attribute of this system is its simplicity. The only decision the pollution control authority must make is the total amount of pollution that is it to be permitted in a particular region—the number of "pollution rights" that will be put up for sale. Unlike the pollution tax system, there is no need to determine the price of pollution rights; the marketplace will do that on its own. Furthermore, with this system, it is easy to differentiate between wilderness areas and industrial regions simply through the number of permits put up for sale.

Hence, we have made the full circle. In Section 1 we demonstrated that the primary problem with pollution is that property rights are not completely assigned—no one owns the air and water. Here, we have argued that the best way to solve the pollution problem is to assign property rights—set up a market for pollution rights. Maryland was the first state to use a system like the one we have decribed, and the EPA is considering a move to this system.

References

Conservation Foundation, *The Conservation Foundation Letter*, various issues.

Dorman, Robert and Nancy Dorfman, eds., *Economics of the Environment*, New York: W. W. Norton & Co., 1972. In this collection, papers of particular note are Larry E. Ruff, "The Economic Common Sense of Pollution," Otto A. Davis and Morton I. Kamien, "Externalities, Information, and Alternative Collective Action."

LeGrand, Julian and Ray Robinson, *The Economics of Social Problems*, New York: Harcourt Brace Jovanovich, 1980.

McConnell, Campbell, *Economics* (6th edition), New York: McGraw-Hill, 1975.

Miller, Roger L., *Economics Today* (4th edition), New York; Harper & Row, 1982.

Siebert, Horst, *Economics of the Environment*, Lexington, Mass.: Lexington Books, 1981.

U.S. Council on Environmental Quality, *Environmental Quality*, 9th Annual Report, 1978.

Wonnacott, Paul and Ronald Wonnacott, *Economics*, New York: McGraw-Hill, 1982.

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